

WHAT IS CLAIMED

1. A method for making membrane electrode assembly, comprising the steps of:  
providing a membrane electrode assembly comprising an anode including a hydrogen oxidation catalyst; a cathode; and a membrane disposed between said anode and said cathode; and  
depositing a peroxide decomposition catalyst in at least one position selected from the group consisting of said anode, said cathode, a layer between said anode and said membrane and a layer between said cathode and said membrane, wherein said peroxide decomposition catalyst has selectivity when exposed to hydrogen peroxide toward reactions which form benign products from said hydrogen peroxide.
2. The method of claim 1, wherein said peroxide decomposition catalyst comprises an element selected from the group consisting of Pt, Pd, Ir, C, Ag, Au, Rh, Ru, Os, Re, Sn, Si, Ti, Zr, Al, Hf, Ta, Nb, Ce and combinations thereof.
3. The method of claim 2, wherein said peroxide decomposition catalyst comprises an element selected from the group consisting of Pt, Pd, Ir, C, Ag, Au, Rh, Ru and combinations thereof.
4. The method of claim 2, wherein said peroxide decomposition catalyst is supported on a support selected from the group consisting of oxides of Ru, Sn, Si, Ti, Zr, Al, Hf, Ta, Nb and Ce, Mn, zeolites, carbon and combinations thereof.
5. The method of claim 1, further comprising the step of depositing an oxygen reduction catalyst in at least one position of said group of positions.
6. The method of claims 5, wherein said oxygen reduction catalyst is selected from the group consisting of oxides of Ru, Sn, Si, Ti, Zr, Al, Hf, Ta, Nb and Ce, Mn, zeolites, carbon and combinations thereof.
7. The method of claim 5, wherein said oxygen reduction catalyst is positioned in a layer between said cathode and said membrane.

8. The method of claim 1, wherein said peroxide decomposition catalyst comprises an element selected from the group consisting of Ag, Au, C and combinations thereof.
9. The method of claim 8, wherein said peroxide decomposition catalyst is supported on carbon.
10. The method of claim 1, wherein said peroxide decomposition catalyst is carbon.
11. The method of claim 1, wherein said peroxide decomposition catalyst is deposited as said layer disposed between said anode and said membrane.
12. The method of claim 11, wherein said layer is electrically connected to said anode.
13. The method of claim 11, further comprising the step of depositing a layer of said peroxide decomposition catalyst between said membrane and said cathode.
14. The method of claim 11, wherein said layer further comprises a portion of said hydrogen oxidation catalyst.
15. The method of claim 11, wherein said layer has a porosity of less than or equal to about 20%.
16. The method of claim 1, wherein said peroxide decomposition catalyst is also deposited in said membrane.
17. The method of claim 16, wherein said depositing step comprises impregnating said peroxide decomposition catalyst into said membrane from a surface of said membrane to a desired depth into said membrane.
18. The method of claim 16, wherein said membrane has an anode surface and a cathode surface and wherein said peroxide decomposition catalyst is deposited in said membrane at said

anode surface and said cathode surface whereby peroxide generated at either of said anode and said cathode is decomposed in the presence of said peroxide decomposition catalyst.

19. The method of claim 1, wherein said peroxide decomposition catalyst is deposited in at least one of said anode and said cathode.

20. The method of claim 19, wherein said peroxide decomposition catalyst is deposited in both said anode and said cathode.

21. The method of claim 20, further comprising depositing a greater concentration of said peroxide decomposition catalyst in said anode than said cathode.

22. The method of claim 20, wherein said anode is more hydrophilic than said cathode.

23. The method of claim 20, further comprising depositing a layer of said peroxide decomposition catalyst between said anode and said membrane.

24. The method of claim 1, wherein said peroxide decomposition catalyst is deposited adjacent to said anode.

25. A method for making a membrane electrode assembly, comprising the steps of: providing a membrane electrode assembly comprising an anode including a hydrogen oxidation catalyst; a cathode; and a membrane disposed between said anode and said cathode; and

depositing a peroxide decomposition catalyst in at least one position selected from the group consisting of said anode, said membrane, said cathode, a layer between said anode and said membrane and a layer between said cathode and said membrane, wherein said peroxide decomposition catalyst has selectivity when exposed to hydrogen peroxide toward reactions which form benign products from said hydrogen peroxide, and wherein said peroxide decomposition catalyst comprises an element selected from the group consisting of Pd, Ir, C, Ag, Au, Rh, Ru, Os, Re, Sn, Si, Ti, Zr, Al, Hf, Ta, Nb, Ce and combinations thereof.

26. The method of claim 25, wherein said peroxide decomposition catalyst comprises an element selected from the group consisting of Pd, Ir, C, Ag, Au, Rh, Ru and combinations thereof.

27. The method of claim 25, wherein said peroxide decomposition catalyst comprises an element selected from the group consisting of Ag, Au, C, and combinations thereof.

28. The method of claim 25, wherein said peroxide decomposition catalyst is supported on a support selected from the group consisting of oxides of Ru, Sn, Si, Ti, Zr, Al, Hf, Ta, Nb, and Ce, Mn, zeolites, carbon and combinations thereof.

29. The method of claim 1 or 25, wherein said depositing step is carried out ex-situ.

30. The method of claim 29, wherein said depositing step comprises mixing said hydrogen peroxide decomposition catalyst with an ionomer to provide a mixture, and forming said mixture into said membrane having said hydrogen peroxide decomposition catalyst disposed therethrough.

31. The method of claim 29, wherein said depositing step comprises swelling said membrane in alcohol to provide a swelled membrane; and inserting said catalyst into said swelled membrane.

32. The method of claim 29, wherein said catalyst is deposited as a catalyst precursor, and further comprising the steps of reducing said catalyst precursor to form said catalyst.

33. The method of claim 29, wherein said depositing step comprises impregnating said membrane with said catalyst.

34. The method of claim 29, wherein said depositing step is carried out so as to provide a substantially uniform distribution of said catalyst through said membrane.

35. The method of claim 29, wherein said depositing step is carried out so as to provide a substantially non-uniform distribution of said catalyst relative to said membrane.

36. The method of claim 35, wherein said depositing step comprises forming a plurality of layers at least one of which contains said catalyst, and laminating said layers together.

37. The method of claim 25, further comprising the step of depositing an oxygen reduction catalyst in at least one position of said group of positions.

38. The method of claims 37, wherein said oxygen reduction catalyst is selected from the group consisting of oxides of Ru, Sn, Si, Ti, Zr, Al, Hf, Ta, Nb and Ce, Mn, zeolites, carbon and combinations thereof.

39. The method of claim 1 or claim 25, wherein said depositing steps is carried out in-situ.

40. The method of claim 39, wherein said depositing step comprises subjecting said MEA to conditions whereby catalyst from at least one of said anode and said cathode migrates into said membrane.